
Multi-angle Imaging SpectroRadiometer (MISR)

Publications list

December 7, 1999

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In the listing to follow, papers available from the MISR library are preceded with a bullet.

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Internet web sites

- <http://www.earth.nasa.gov> (NASA's Earth Science Enterprise)
 - <http://eos.nasa.gov> or <http://eospso.gsfc.nasa.gov> (EOS science project office)
 - <http://www-misr.jpl.nasa.gov> (Multi-angle Imaging SpectroRadiometer - MISR)
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Science

Science overview

Refereed Journals

Diner et al., 1999. New directions in Earth Observing: Scientific applications of multi-angle remote sensing. *Bull. Am. Meteorol. Soc.*, (revised May, 1999).

- Diner, D.J., J.C. Beckert, T.H. Reilly, C.J. Bruegge, J.E. Conel, R. Kahn, J.V. Martonchik, T.P. Ackerman, R. Davies, S.A.W. Gerstl, H.R. Gordon, J-P. Muller, R. Myneni, R.J. Sellers, B. Pinty, and M.M. Verstraete (1998). Multiangle Imaging SpectroRadiometer (MISR) description and experiment overview. *IEEE Trans. Geosci. Rem. Sens.*, Vol. 36, 1072-1087.

Conference papers/ Workshop proceedings

- Bruegge, C.J., J.V. Martonchik, D.J. Diner, R.A. Kahn, and R.A. West (1993). Calibration and Atmospheric Retrieval Techniques Planned for the Multi-angle Imaging SpectroRadiometer (MISR). In *Workshop on Atmospheric Correction of Landsat Imagery*, 29 June, Torrance, Ca.
- Diner, D.J., J.V. Martonchik, C.J. Bruegge, E.D. Danielson, L.E. Hovland, T.P. Ackerman, R. Davies, S.A.W. Gerstl, H.R. Gordon (1990). Atmospheric and surface observations from EOS with the Multi-angle Imaging SpectroRadiometer. *AIAA 28th Aerospace*, Reno, Nevada.
- Diner, David J., Wedad A. Abdou, Carol J. Bruegge, James E. Conel, Ralph A. Kahn, John V. Martonchik, Susan R. Paradise, and Robert A. West (1995). Status of the Multi-angle Imaging SpectroRadiometer instrument for EOS-AM1 and its application to remote sensing of aerosols. In *IGARSS Symposium*, 10-14 July, Florence, Italy.
- Kahn, R., J.V. Martonchik, D.J. Diner, and R.A. West (1997). Multi-Angle Remote Sensing of Aerosols Over Ocean. *Proceedings of the IEEE International Geosciences and Remote Sensing Society (IGARSS) Conference*, Singapore, August 2-7, 1997, paper 97.0877.

Aerosol retrieval

Refereed Journals

- Abdou, W.A., J.V. Martonchik, R.A. Kahn, R.A. West, and D.J. Diner (1997). A modified linear-mixing method for calculating atmospheric path radiances of aerosol mixtures. *J. Geophys. Res. Atmos.*, Vol. 102, pp. 16,883-16,888.
- Diner, D.J. and J.V. Martonchik (1985). Influence of aerosol scattering on atmospheric blurring of surface features. *IEEE Trans. on Geosci. Rem. Sens.*, Vol. GE-23 (5), pp. 618-624.
- Diner, D.J. and J.V. Martonchik (1985). Atmospheric transmittance from spacecraft using multiple view angle imagery. *Applied Optics*, Vol. 24 (2), pp. 3503-3511.
- Kahn, Ralph, Pranab Banerjee, and Duncan McDonald (2000). The sensitivity of multi-angle imaging to natural mixtures of aerosols over ocean. Submitted to *J. Geophys. Res.* Nov. 1999.
- Kahn, Ralph, Pranab Banerjee, Duncan McDonald, and David J. Diner (1998). Sensitivity of multiangle imaging to aerosol optical depth and to pure-particle size distribution and composition over ocean. *J. Geophys. Res.*, **103(D24)**, pp. 32,195-32,213, Dec. 27.
- Kahn, R., R. West, D. McDonald, B. Rheingans, and M.I. Mishchenko (1997). Sensitivity of Multi-angle remote sensing observations to aerosol sphericity. *J. Geophys. Res.*, Vol. 102, pp. 16,861-16,870.
- Martonchik, J. (1997). Determination of aerosol optical depth and land surface directional reflectances using multi-angle imagery. *J. Geophys. Res., Atmos.*, Vol. 102, pp. 17,015-17,022.
- Martonchik, J.V. and D.J. Diner (1992). Retrieval of aerosol optical properties from multi-angle satellite imagery. *IEEE Trans. Geosci. Rem. Sens.*, vol. 30, pp. 223-230.
- Martonchik, J.V., D.J. Diner, R. Kahn, T.P. Ackerman, M.M. Verstraete, B. Pinty, and H.R. Gordon (1998). Techniques for the retrieval of aerosol properties over land and ocean using multi-angle imaging. *IEEE Trans. Geosci. Rem. Sens.*, Vol. 36, pp. 1212-1227.
- Mishchenko, M.I., L. Travis, R. Kahn, and R. West (1997). Modeling phase functions for dust-like tropospheric aerosols using a shape mixture of randomly oriented polydisperse spheroids. *J. Geophys. Res.*, Vol. 102, pp. 16,831-16,847.
- Wang, M. and H.R. Gordon (1993). Retrieval of the Columnar Aerosol Phase Function and Single Scattering Albedo from Sky Radiance over the Ocean: Simulation. *Applied Optics*, 32 4598-4609.
- Wang, M. and H.R. Gordon (1994). Estimating aerosol optical properties over the oceans with MISR: Some preliminary studies. *Applied Optics*, 33, 4042-4057.
- Wang, M. and H.R. Gordon (1994). Radiance reflected from the ocean-atmosphere system: Synthesis from individual components of the aerosol size distribution. *Applied Optics*, 33, 7088-7095.
- West, R.A., L. R. Doose, A.M. Eibl, M.G. Tomasko, and M.I. Mishchenko (1997). Laboratory measurements of mineral dust scattering phase function and linear polarization. *J. Geo. Res. Atmos.*, Vol. 102, pp. 16,871-16,881.

Conference papers/ Workshop proceedings

- Bruegge, C.J., J.V. Martonchik, D.J. Diner, R.A. Kahn, and R.A. West (1993). Calibration and atmospheric retrieval techniques planned for the Multi-angle Imaging SpectroRadiometer (MISR). *Workshop on Atmospheric Correction of Landsat Imagery*, 29 June, Torrance, Ca.
- Martonchik, John (1995). Atmospheric correction of vegetation index using multi-angle measurements. *IGARSS'95 Symposium*, 10-14 July, Florence, Italy.
- Kahn, Ralph (1997). Quantitative Aerosol Data from the EOS-MISR Instrument. *NASA Goddard Institute for Space Studies Aerosol Workshop: How Can We Use Satellite Data, global Models, and Analysis to Advance Our Understanding of Aerosol Climate Effects?*, New York, NY, June 2-3.

- Kahn, R. (1997). Remote sensing of aerosols with multi-angle imaging. Conference on Optical Remote Sensing of the Atmosphere, Optical Society of America, Santa Fe, New Mexico, Vol. 5 , pp. 90-91.
- Kahn, Ralph (1998). The Promise of Multiangle Imaging for Aerosol Remote Sensing. Gordon Research Conference on Solar Radiation & Climate, Plymouth State College, June 14-19.
- Kahn, R., D.J. Diner, and J.V. Martonchik (1998). Multiangle remote sensing of aerosols over ocean. IEEE International Geosciences and Remote Sensing Symposium (IGARSS'98), C11.11, Seattle, WA, July 6-10.
- Kahn, R., D.J. Diner, J.V. Martonchik, and R.A. West (1997). Multiangle remote sensing of aerosols over ocean. Visual Air Quality: Aerosols and Global Radiation Balance, Proc. of a conference sponsored by the Air and Waste Management Association of the American Geophysical Union, Bartlett, New Hampshire, Sept. 9-12, Vol. 1, pp. 235-242.

Atmospheric correction

Conference papers/ Workshop proceedings

- Diner, D.J., J.V. Martonchik, E.D. Danielson, and C.J. Bruegge (1988). Application of 3-D radiative transfer theory to atmospheric correction of land surface images. IGARSS'88, Edinburgh, Scotland, 13-16 Sept. Ref. ESA SP-284 (IEEE 88CH2497-6), p. 1215-1218.
- Diner, D.J., J.V. Martonchik, E.D. Danielson, and C.J. Bruegge (1989). Atmospheric correction of high resolution land surface images. IGARSS'89, 10-14 July, Vancouver, B.C., Canada.
- Diner, D.J., S.R. Paradise, J.V. Martonchik (1994). Development of an aerosol opacity retrieval algorithm for use with multi-angle land surface images. IGARSS'94, 8-12 Aug., Pasadena, Ca.
- Martonchik, J.V., D.J. Diner, E.D. Danielson, and C.J. Bruegge (1990). Application of heterogeneous scene models to retrieval of land surface and atmospheric optical properties from space. IGARSS'90, 20-24 May, Washington D.C., pp. 179-182.

Cloud studies

Refereed Journals

- Astin, I. and L. Di Girolamo (1998). A general formulism for the distribution of total length of a geophysical parameter along a finite transect. IEEE Trans. Geosci. Remote Sens. (in press).
- Di Girolamo, L. and R. Davies (1994). A band-differenced angular signature technique for cirrus cloud detection. IEEE Trans. Geosci. Rem. Sens., Vol. 36, pp. 890-896.
 - Di Girolamo, L. and R. Davies (1995). The image navigation cloud mask for the Multi-angle Imaging SpectroRadiometer (MISR). J. Atmos. Oceanic Tech. 12,1215-1228.
 - Di Girolamo, L., T. Varnai and R. Davies (1998). The apparent breakdown of reciprocity in reflected solar radiances. J. Geophys. Res. 103, pp. 8795-8803.
 - Di Girolamo, L., and R. Davies (1997). Cloud fraction errors caused by finite resolution measurements (1997) , J. Geophys. Res., 102, 1739-1756.
 - Hagen, D., D. Crisp, J.-F. Blavier, L. Di Girolamo and T. Ackerman (1998). Profiling the shortwave downwelling irradiance in the troposphere using aerobots. Geophys. Res. Lett. 25, pp. 1887-1890.
 - Loeb, N. and R. Davies (1996). Observational evidence of plane parallel model biases: Apparent dependence of cloud optical depth on solar zenith angle. J. Geophys. Res. 101(D1), 1621-1634.
 - Loeb, N.G., and R. Davies (1997). Angular dependence of observed reflectances: a comparison with plane parallel theory. J. Geophys. Res., 102, 6865-6881.

- Loeb, N.G., T. Várnai, and R. Davies (1997). Effect of cloud inhomogeneities on the solar zenith angle dependence of nadir reflectance. *J. Geophys. Res.*, 102, 9387–9395.
- Oreopoulos, L., and R. Davies (1998). Plane parallel albedo biases from satellite observations. Part I: dependence on resolution and other factors. *J. Climate*, 11, 919–932.
- Oreopoulos, L., and R. Davies (1998). Plane parallel albedo biases From satellite observations. Part II: parameterizations for bias removal. *J. Climate*, 11, 933–944.
- Várnai, T., and R. Davies (1999). Effects of cloud heterogeneities on shortwave radiation: comparison of cloud top variability and internal heterogeneity. *J. Atmos. Sci.* (in press).

Conference papers/ Workshop proceedings

- Davies, R., L. Oreopoulos, N. Loeb, and T. Varnai (1996). Effects of heterogeneity on observations of cloud radiative forcing. GEWEX conference, Washington, D.C., 19-21June.
- Davies, R. and T. Varnai (1996). Albedo algorithms and errors from multi-angle satellite measurements. International Radiation Symposium, Fairbanks, Alaska, 19-23 Aug.
- Di Girolamo, L., (1998). A comparison of 15 global, non-parametric, automated threshold selection procedures for cloud detection. Proc. 9th Conf. Sat. Meteo. Ocean., May 24-29, Paris, France, 197-200.
- Di Girolamo, L., S. Ackerman and E. Clothiaux (1998). Proc. 9th Conf. Sat. Meteo. Ocean., May 24-29, Paris, France, 555-556.
- Di Girolamo, L. and R. Davies (1997). Concerns regarding the application of reciprocity to shortwave radiation measurements. Proc. 9th Conf. Atmos. Radiation, Feb. 2-7, Long Beach, CA, 283-286.
- Di Girolamo, L. and R. Davies (1994). Optimizing the use of 670 nm and 860 nm radiometric data for cloud detection. Proc. 8th Conf. Atmos. Radiation, Jan. 23-28, Nashville, TN, 466-467.
- Di Girolamo, L. and R. Davies (1992). On the detection of cirrus clouds from satellite measurements. Proc. 11th Int. Conf. Clouds Precip., Aug. 17-21, Montreal, Canada, 1057-1060.
- Loeb, N.G. and R. Davies (1996). Three-dimensional cloud effects on satellite measurements of reflected solar radiation. International Radiation Symposium, Fairbanks, Alaska, 19-23Aug.
- Oreopoulos, L. and R. Davies (1996). Plane-parallel albedo bias from satellite observations. International Radiation Symposium, Fairbanks, Alaska, 19-23 Aug.
- Varnai, T. and R. Davies (1996). Quantitative analysis of radiative inhomogeneity effect. International Radiation Symposium, Fairbands, Alaska, 19-23 Aug.

Ph.D. Thesis/ Technical Reports

- Di Girolamo, L. (1996). Detecting and interpreting clouds from satellite radiometric measurements with application to the Multi-angle Imaging SpectroRadiometer (MISR). Ph.D. Thesis, McGill University, Montreal, Canada.
- Loeb, N. (1996). Angular dependence of observed reflectances: A comparison with plane parallel theory. Ph.D. Thesis, McGill University, Montreal, Canada.
- Oreopoulos, L. (1996). Plane parallel albedo bias from satellite observations. Ph.D. Thesis, McGill University, Montreal, Canada.
- Varnai, T. (1996). Reflection of solar radiation by inhomogeneous clouds. Ph.D. Thesis, McGill University, Montreal, Canada.

Ocean studies

Refereed Journals

- Clark, D.K., H.R. Gordon, K.J. Voss, Y. Ge, W. Broenkow, and C. Trees (1977). Validation of Atmospheric Correction over the Oceans. *Jour. Geophys. Res.*, **102D**, pp. 17209-17217.

- Gordon, H.R. (1977). Atmospheric Correction of Ocean Color Imagery in the Earth Observing System Era. *Jour. Geophys. Res.*, **102D**, pp. 17081-17106.
- Gordon, H.R. (1988). In-orbit calibration strategy for ocean color sensors. *Remote Sensing of Environment*, **63**, pp. 265-278.
- Gordon, H.R., T. Du, and T. Zhang (1977). Atmospheric Correction of Ocean Color Sensors: Analysis of the Effects of Residual Instrument Polarization Sensitivity, *Applied Optics*, **36**, pp. 6938-6948.
- Gordon, H.R., T. Du, and T. Zhang (1997). Remote sensing ocean color and aerosol properties: resolving the issue of aerosol absorption, *Applied Optics*, **36**, pp. 8670-8684.
- Gordon, H.R. and T. Zhang (1966). How well can radiance reflected from the ocean-atmosphere system be predicted from measurements at the sea surface? *Applied Optics*, **35**, pp. 6527-6543.
- Gordon, H.R., T. Zhang, F. He, and K. Ding (1977). Effects of stratospheric aerosols and thin cirrus clouds on atmospheric correction of ocean color imagery: Simulations. *Applied Optics*, **36**, 682-697.
- Hansen, J., M. Sato, R. Ruedy, A. Lacis, K. Asamoha, K. Beckford, S. Borenstein, E. Brown, B. Cairns, B. Carlson, B. Curran, S. de Castro, L. Druyan, P. Etwarrow, T. Ferede, M. Fox, G. Gaffen, J. Glascoe, H. Gordon, S. Hollandsworth, X. Jiang, C. Johnson, N. Lawrence, J. Lean, J. lerner, K. Lo, J. Logan, A. Luckett, M.P. McCormick, R. McPeters, R. Miller, P. Minnis, I. Ramberran, G. Russell, P. Stone, I. Tegen, S. Thomas, L. Thomason, A. Thompson, J. Wilder, R. Willson, and J. Zawodny (1977). Forcings and chaos in interannual to decadal climate change, *Jour. Geophys. Res.*, **102D**, pp. 25679-25720.
- Kaufman, Y.J., D. Tanre, H.R. Gordon, T. Nakajima, J. Lenoble, R. Frouin, H. Grassl, B.M. Herman, M.D. King, and P.M. Teillet (1977). Passive Remote Sensing of Tropospheric Aerosol and Atmospheric Correction for the Aerosol Effect, *Jour. Geophys. Res.*, **102D**, pp. 16815-16830.
- Moore, K.D., K.J. Voss, and H.R. Gordon (1998). Spectral reflectance of whitecaps: Instrumentation, calibration, and performance in coastal waters, *Jour. Atmos. Ocean. Tech.*, **15**, pp. 496-509.
- Wang, M. and H.R. Gordon (1995). Estimation of aerosol columnar size distribution and optical thickness from the angular distribution of radiance exiting the atmosphere: simulations. *Applied Optics*, **34**, pp. 6989-7001.
- Yang, H., H.R. Gordon and T. Zhang (1995). Island perturbation to the sky radiance over the ocean: Simulations. *Applied Optics*, **34**, pp. 8354-8362.
- Yang, H. and H.R. Gordon (1977). Remote sensing of ocean color: Assessment of the water-leaving radiance bidirectional effects on the atmospheric diffuse transmittance. *Applied Optics*, **36**, pp. 7887-7897.
- Yang, H. and H.R. Gordon (1998). Retrieval of the Columnar Aerosol Phase Function and Single Scattering Albedo from Sky Radiance over Land: Simulations, *Applied Optics*, **37**, pp. 978-997.
- Zhang T. and H.R. Gordon (1977). Columnar aerosol properties over oceans by combining surface and aircraft measurements: sensitivity analysis. *Applied Optics*, **36**, pp. 2650-2662.
- Zhang, T. and H.R. Gordo (1977). Retrieval of elements of the columnar aerosol scattering phase matrix from sky radiance over the ocean: simulations, *Applied Optics*, **36**, pp. 7948-7959.

Surface properties

Refereed Journals

- Knyazikhin, Yu., J. Kranick, R.B. Myneni, O.Panfyorov, and G.Gravenhorst (1998). Influence of small-scale structure on radiative transfer and photosynthesis in vegetation cover. *J. Geophys. Res.*, **103(D6)**, pp. 6133-6144.
- Knyazikhin, Y., J.V. Martonchik, D.J.Diner, R.B. Myneni, M. Verstraete, B.Pinty, and N. Gobron (1998). Estimation of vegetation canopy leaf area index and fraction of absorbed photosynthetically active radiation from atmosphere-corrected MISR data. *J. Geophys. Res.*, **103(D24)**, pp. 32,239-32,256 , Dec. 27.
 - Knyazikhin, Y., J.V., Martonchik, R.B. Myneni, D.J. Diner, and S.W. Running (1998). Synergistic algorithm for estimating vegetation canopy leaf area index and fraction of absorbed photosynthetically active radiation from MODIS and MISR data. *J. Geophys. Res.*, **103(D24)**, pp. 32,257-32,275 , Dec. 27.
- Knyazikhin, Yu., G. Miessen, O. Panfyorov, and G. Gravenhorst (1997). Small-scale study of three-dimensional distribution of photosynthetically active radiation in a forest. *Agric. For. Meteorol.*, **88**, pp. 215-239.
- Knyazikhin, Y., G. Miessen, O. Panfyorov, R.B. Myneni, and G. Gravenhorst (1998). Influence of vegetation canopy heterogeneity on the interpretation of remotely sensed reflectance measurements. *IEEE Trans. Geosci. Remote Sens.*, (submitted for publication).
- Martonchik, J.V. (1994). Retrieval of surface directional reflectance properties using ground level multi-angle measurements. *Remote Sens. Environ.* **50**: 303-316.
 - Martonchik, J.V., D.J. Diner, B. Pinty, M.M. Verstraete, R.B. Myneni, Yu. Knyazikhin, and H.R. Gordon (1998). Determination of land and ocean reflective, radiative, and biophysical properties using multi-angle imaging. *IEEE Trans. Geosci. Rem. Sens.*, Vol. 36, pp. 1266-1281.
- Myneni, R.B. and G. Asrar (1993). Radiative transfer in three dimensional atmosphere-vegetation media. *J. Quant. Spectroscop. Radiat. Transfer*, **49**, pp. 585-598.
- Myneni, R.B. and G. Asrar (1994). Atmospheric effects and spectral vegetation indices. *Remote Sens. Environ.*, **47**, pp. 390-402.
- Myneni, R.B., G. Asrar, and S.A.W. Gerstl (1990). Radiative transfer in three dimensional leaf canopies. *Transport Theory and Statistical Physics*, **19**, pp. 205-250.
- Myneni, R.B., G. Asrar, and F.G. Hall (1992). A three dimensional radiative transfer method for optical remote sensing of vegetated land surfaces. *Remote Sens. Environ.*, **41**, pp. 105-121.
- Myneni, R. B., F.G. Hall, P.J. Sellers, and A. L. Marshak (1995). The meaning of spectral vegetation indices. *Trans. Geosc. Remote Sens.* **33**, pp. 481-486.
- Myneni, R. B., C. D. Keeling, C. J. Tucker, G. Asrar, and R. R. Nemani (1997). Increased plant growth in the northern high latitudes from 1981-1991. *Nature*, **386**, pp. 698-701.
- Myneni, R. B., S. O. Los, and C.J. Tucker (1996). Satellite-based identification of linked vegetation index and sea surface temperature anomaly areas from 1982-1990 for Africa, Australia and South America. *Geophysical Res. Letters*, **23**, pp. 729-732.
- Myneni, R.B., S. Maggion, J. Iaquinta, J. L. Privette, N. Gobron, B. Pinty, M. M. Verstraete, D. S. Kimes, and D. L. Williams (1995). Optical remote sensing of vegetation: modelling, caveats and algorithms. *Remote Sens. Environ.*, **51**, pp. 169-188.
- Myneni, R. B., R. R. Nemani, and S.W. Running (1997). Algorithm for the estimation of global land cover, LAI and FPAR based on radiative transfer models. *IEEE Trans. Geosc. Remote Sens.*, **35**, pp. 1380-1393.
- Myneni, R. B., C. J. Tucker, G. Asrar, and C. D. Keeling (1998). Interannual variations in satellite-sensed vegetation index data from 1981 to 1991. *J. Geophys. Res.*, **103 (D6)**, pp. 6145-6160.

- Myneni, R.B. and D. L. Williams (1994). On the relationship between FAPAR and NDVI. *Remote Sens. Environ.*, **49**, 200-211.
- Verstraete, Michel M., Pinty, Bernard and Myneni, Ranga B. (1996). Potential and limitations of information extraction on the terrestrial biosphere from satellite remote sensing. *Remote Sensing of Environment*, Vol. 58, p. 201-214.
- Zhang, Y., Y. Tian, Y. Knyazikhin, J.V. Martonchik, D.J. Diner, M. Leroy, R.B. Myneni (1999). Prototyping of MISR LAI and FPAR Algorithm with POLDER data over Africa. *IEEE Trans. on Geoscience and Remote Sensing*, submitted April.

Conference papers/ Workshop proceedings

- Borel, C.C., and S.A.W. Gerstl (1996). Using BRDFs for accurate albedo calculations and adjacency effect corrections. *Int. Workshop on Multiangular Rem. Sens.: Measurements, Models and Applications*, Beijing, China, 13-18 Sept.
- Martonchik, J.V. (1996). Retrieval of bidirectional reflectance factors and directional hemispherical reflectances using space-based and airborne multi-angle observations. *Int. Workshop on Multiangular Rem. Sens.: Measurements, Models and Applications*, Beijing, China, 13-18 Sept.
- Martonchik, J.V. and J.E. Conel (1994). Retrieval of surface reflectance and atmospheric properties using ASAS imagery. *IGARSS'94*, 8-12Aug, Pasadena, Ca.
 - Martonchik, J.V., E.D. Danielson, D.J. Diner, and C.J. Bruegge (1993). Retrieval of surface directional reflectance and hemispherical albedo using multi-angle measurements. *IGARSS'93*, 18-21 Aug., Tokyo, Japan, IEEE: 93CH3294, Lib. Cong: 93-77594, p. 1103-1106.
- Martonchik, J.V., D.J. Diner, E.D. Danielson, C.J. Bruegge (1992). Retrieval of surface properties from space using multi-angle imagery, *IGARSS'92*, 26-29 May, Houston, Texas.
- Verstraete, M.M., O. Engelsen, N. Gobron, B. Pinty and J.V. Martonchik (1996). Advanced models for multiangular remote sensing data interpretation. *Int. Workshop on Multiangular Rem. Sens.: Measurements, Models and Applications*, Beijing, China, 13-18 Sept.

Ph.D. Thesis/ Technical Reports

- Engelsen, Ola, Bernard Pinty, Michel M. Verstraete, and John V. Martonchik (1996). Parametric Bidirectional Reflectance Factor Models: Evaluation, Improvements and Applications. EC Joint Research Centre, Ispra, Italy, Technical Report EUR 16426 EN.

Top-of-atmosphere albedo

Conference papers/ Workshop proceedings

- Borel, C.C. and S.A.W. Gerstl (1996). Algorithms to compute the top-of-the-atmosphere albedo for clear-sky conditions from multi-angle MISR observations. *Proc. International Geoscience and Remote Sensing Symposium*, Lincoln, NE, May 27-31.
- Borel, C.C., C. Tornow, and S.A.W. Gerstl (1996). Accurate top-of-the atmosphere albedo determination from multiple views of the MISR instrument. In *Aerospace Sensing*, Proc. SPIE Vol. 2758, April.

Validation

Refereed Journals

- Abdou, W.A., C.J. Bruegge, M.C. Helmlinger, B.J. Gaitley, W.C. Ledebot, S.H. Pilorz, J.E. Conel, and J.V. Martonchik (1999). Vicarious reflectance-based absolute radiometric calibration of AirMISR, Submitted, *Remote Sens. of Environment*.
- Brown., S.W., B. Carol Johnson, H.W. Yoon, J.J. Butler, R. Barnes, S. Biggar, P. Spyak, K. Thome, E. Zalewski, M. Helmlinger, C. Bruegge, S. Schiller, G. Fedosejevs, R. Gauthier, S. Tsuchida,

- S. Machida, and T. Matsunaga (1998). Radiometric characterization of field radiometers in support of the 1997 Lunar Lake Nevada experiment to determine surface reflectance and top-of-atmosphere radiance. To submit soon.
- Bruegge, C.J., J.E. Conel, R.O. Green, J.S. Margolis, R.G. Holm, and G. Toon (1992). Water-Vapor Column Abundance Retrievals During FIFE, *J. Geophys. Res.*, Vol. 97 (D17), 18759-18768.
 - Bruegge, C.J., R.N. Halthore, B. Markham, M. Spanner, and R. Wrigley (1992). Aerosol Optical Depth Retrievals Over the Konza Prairie, *J. Geophys. Res.*, Vol. 97 (D17), 18743-18758.
 - Marchand, Roger T. and Thomas P. Ackerman (2000). Multiangle observations of arctic clouds from FIRE ACE: June 3, 1998 case study. Submitted.

Conference papers/ Workshop proceedings

Conel, J.E., W.C. Ledeboer, S.H. Pilorz, J.V. Martonchik, R.A. Kahn, W.A. Abdou, C.J. Bruegge, M.C. Helmlinger and B.J. Gaitley (1997). Ground-based validation of the EOS Multi-angle Imaging Spectroradiometer (MISR) aerosol retrieval algorithms and science data products. IGARSS '97, Singapore, 2-7 August.

Conel, J.E., W.A. Abdou, C.J. Bruegge, B.J. Gaitley, M.C. Helmlinger, W.C. Ledegoer, S.H. Pilorz, and J.V. Martonchik. Radiative closure experiments at a cloud-free desert site, Nevada, as part of MISR algorithm validation. Air and Waste Management Association conference proceedings, Bartlett, NH, 9-12Sep97.

3

Instrument

Instrument overview

Refereed Journals

Diner, D.J. (1990). EOS Multi-angle Imaging SpectroRadiometer. In *Remote Sensing of the Biosphere*, Proc. SPIE 1300, April, p. 163-171.

Diner, D.J., C.J. Bruegge, J.V. Martonchik, T.P. Ackerman, R. Davies, S.A.W. Gerstl, H.R. Gordon, P.J. Sellers, and J. Clark, J.A. Daniels, E.D. Danielson, V.G. Duval, K.P. Klassen, G.W. Lilenthal, D.I. Nakamoto, R. Pagano, T.H. Reilly (1989). MISR: A Multi-angle Imaging SpectroRadiometer for geophysical and climatological research from EOS. *IEEE Trans. Geoscience and Remote Sens.*, Vol. 27, No. 2, March, p. 200-214.

Diner, D.J., C.J. Bruegge, J.V. Martonchik, G.W. Bothwell, E.D. Danielson, V.G. Ford, L.E. Hovland, K.L. Jones, M.L. White (1991). A Multi-angle Imaging SpectroRadiometer for terrestrial remote sensing from the Earth Observing System. *Internatl. J. Imaging Sys. and Tech.*, Vol. 3, 92-107.

Conference papers/ Workshop proceedings

Bruegge, C.J. and D.J. Diner. Instrument verification tests on the Multi-angle Imaging SpectroRadiometer (MISR) (1997). In *Earth Observing System II*, Proc. SPIE 3117, San Diego, CA, July.

- Bruegge, C.J., M.L. White, N.C.L. Chrien, E.B. Villegas, and V.G. Ford (1993). Multi-angle Imaging SpectroRadiometer (MISR) design issues influenced by performance requirements.

In *Sensor Systems for the Early Earth Observing System Platforms*, Proc. SPIE **1939**, April, 104-113.

Diner, D.J., C.J. Bruegge, T. Deslis, V.G. Ford, L.E. Hovland, D.J. Preston, M.J. Shterenberg, E.B. Villegas, and M.L. White (1993). Development status of the EOS Multi-angle Imaging SpectroRadiometer (MISR). In *Sensor Systems for the Early Earth Observing System Platforms*, Proc. SPIE **1939**, April, 94-103.

- Diner, D.J., J.V. Martonchik, and C.J. Bruegge (1994). Bi-directional reflectance measurements from space with the EOS Multiangle Imaging SpectroRadiometer (MISR). In *Earth Observing System Experiments.*, AIAA 32nd Aerospace Sciences Meeting, paper #**94-0598**, January 12, Reno, Nevada.
- Diner, D.J., C.J. Bruegge, J.V. Martonchik, G.W. Bothwell, L.E. Hovland, and K.L. Jones (1991). Global environmental monitoring with the EOS Multi-angle Imaging SpectroRadiometer (MISR). IGARSS, Helsinki.
- Woodhouse, R.M., C.J. Bruegge, B.J. Gaitley, G. Saghir, and N. Chrien. Multi-angle Imaging SpectroRadiometer (MISR) Ancillary Radiometric Product (ARP) (1997). In *Earth Observing System II*, Proc. SPIE **3117**, San Diego, CA, July.

Ph.D. Thesis/ Technical Reports

King, M.D., D.D. Herring, and D.J. Diner (1995). The Earth Observing System: a space-base program for assessing mankind's impact on the global environment. Optics and Photonics News, Vol. 6(1).

AirMISR

Bruegge, Carol J., Wedad A. Abdou, Nadine L. Chrien, Barbara J. Gaitley (1998). AirMISR spectral and radiometric performance studies. In *Earth Observing System III*, Proc. SPIE **3439**, San Diego, CA, 19-21 July.

- Chrien, Nadine L., Carol J. Bruegge, Barbara J. Gaitley (1999). AirMISR laboratory calibration and in-flight performance results. Submitted to *Remote Sens. Environment*.
- Diner, D.J., L.M. Barge, C.J. Bruegge, T.G. Chrien, J.E. Conel, M.L. Eastwood, J.D. Garcia, M.A. Hernandez, C.G. Kurzweil, W.C. Ledebotter, N.D. Pignatano, C.M. Sarture, and B.G. Smith (1998). The Airborne Multi-angle SpectroRadiometer (AirMISR): instrument description and first results. *IEEE Trans. Geosci. Rem. Sens.*, Vol. 36, pp. 1339-1349.

Diffuse panel studies

Refereed Journals

- Bruegge, C.J., A.E. Stiegman, R.A. Rainen, A.W. Springsteen (1993). Use of Spectralon as a diffuse reflectance standard for in-flight calibration of earth-orbiting sensors. *Opt. Eng.* **32**(4), 805-814.
- Early, E.A., P.Y. Barnes, B.C. Johnson, J.J. Butler, C.J. Bruegge, S.F. Biggar, P.R. Spyak, M.M. Pavlov (1999). Bidirectional reflectance round-robin in support of the Earth Observing System program. Submitted to *J. Atmos. and Oceanic Tech.*
- Haner, D., B.T. McGuckin, and C.J. Bruegge (1999). Polarization characteristics of Spectralon illuminated by coherent light. *Appl. Opt.* **38**(30), pp. 6350-6356.
- Hilsenrath, E., H. Herzig, D.E. Williams, C.J. Bruegge, A.E. Stiegman (year?). Effects of space shuttle flight on the reflectance characteristics of diffusers in the near-infrared, visible, and ultraviolet regions. *Opt. Eng.* **33**(11), 3675-3682.
- McGuckin, B.T., D.A. Haner, and R.T. Menzies (1997). Multiangle Imaging Spectroradiometer: optical characterization of the calibration panels. *Applied Optics* **36**(27), 20 September.

- McGuckin, B.T., D.A. Haner, R.T. Menzies, C. Esproles and A.M. Brothers (1996). Directional reflectance characterization facility and measurement methodology. *Appl. Opt.* 35 (24), 4827-4834.
- Johnson, B. Carol, P.Y. Barnes, T.R. O'Brian, J. J. Butler, C. J. Bruegge, S. Biggar, P.R. Spyak, and M. M. Pavlov (1998). Initial results of the bi-directional reflectance characterization round-robin in support of EOS AM-1. Conference issue: New Developments and Applications in Optical Radiometry (NEWRAD '97). *Metrologia*, 35, 609-613.
- Stiegman, A.E., C.J. Bruegge, A.W. Springsteen (1993). Ultraviolet stability and contamination analysis of Spectralon diffuse reflectance material. *Opt. Eng.* 32(4), 799-804.

Conference papers/ Workshop proceedings

- Barnes, P.Y., E.A. Early, B. Johnson, J.J. Butler, C.J. Bruegge, S.F. Biggar, P.R. Spyak, and M. Pavlov (1998). Intercomparison of reflectance measurements. In SPIE 3425, Optical Diagnostic methods for inorganic transmissive materials, San Diego, 20-21 July.
- Bruegge, C.J., R.A. Rainen, D.F. Lewis, C. Hsieh, and S. Petrov (1993). Studies on thermal-control paints for use as diffuse targets in the calibration of flight sensors. In *Passive Materials for Optical Elements II*, Proc. SPIE 2018, San Diego, Ca., July 14-15, 114-124.
 - Bruegge, C.J., A.E. Stiegman, D.R. Coulter, R.R. Hale, D. J. Diner, and A.W. Springsteen (1991). Reflectance stability analysis of Spectralon diffuse calibration panels. SPIE Vol. 1493 Calibration of Passive Remote Observing Optical and Microwave Instrumentation, Orlando, Florida, 3-5 April.
 - Flasse, S.P., M.M. Verstraete, B. Pinty, and C.J. Bruegge (1993). Modeling Spectralon's bidirectional reflectance for in-flight calibration of Earth-orbiting sensors. In Recent Advances in Sensors, Radiometric Calibration, and Processing of Remotely Sensed Data, Proc. SPIE 1938, April, 100-108.
 - Guzman, C.T., J.M. Palmer, C.J. Bruegge, E.A. Miller (1991). Requirements for a solar diffuser and measurements of some candidate materials. SPIE 1493 Calibration of Passive Remote Observing Optical and Microwave Instrumentation, Orlando, Florida, 3-5 April, pp. 120-131.
 - Hilsenrath, E., H. Herzig, D.E. Williams, C.J. Bruegge, and A.E. Stiegman (1993). Effects of space shuttle flight on the reflectance characteristics of diffusers in the NIR, VIS, and UV. In *Passive Materials for Optical Elements II*, Proc. SPIE 2018, San Diege, Ca., July 14-15.
 - Petrov, S.B., J.E. Leland, B. Chommeloux, C.J. Bruegge, G. Gourmelon (1994). Phase I. Analysis of Spectralon material for use in on-board calibration systems for the Medium Resolution Imaging Spectrometer (MERIS). In Optical Technology for Space Instrumentation, Proc. EUROPT, Garmisch-Partenkirchen FRG, April 18-22.

Engineering studies

Conference papers/ Workshop proceedings

- Al-Jumaily, Ghanim A. (1992). Effects of radiation on the optical properties of glass materials. Proc. SPIE 1761, 26-34.
- Chrien, N.C.L, E.C. Hagerott, M.L. White, C.J. Bruegge, and E.R. Freniere (1994). Contrasting target, stray-light, and other performance metrics for MISR. IGARSS '94, 8-12Aug, Pasadena, Ca.

Radiometric standards

Conference papers/ Workshop proceedings

- Jorquera, C., C.J. Bruegge, V.G. Duval (1992). Evaluation of high quantum efficiency silicon photodiodes for calibration in the 400 nm to 900 nm spectral region. In *Infrared Technology XVIII*. Proc. SPIE 1762, 135-144.
- Jorquera, C.R., V.G. Ford, V.G. Duval, and C.J. Bruegge (1995). State of the art radiometer standards for NASA's Earth Observing System. Aerospace Applications Conference, 5-10Feb, Snowmass, CO.
- Jorquera, C.R., R. Korde, V.G. Ford, V.G. Duval, C.J. Bruegge (1994). Design of new photodiode standards for use in the MISR in-flight calibrator. IGARSS '94, 8-12Aug, Pasadena, Ca.
-

4

Calibration and testing

Calibration overview

Refereed Journals

- Bruegge, C.J., V.G. Duval, N.L. Chrien, R.P. Korechoff, B.J. Gaitley, and E.B. Hochberg (1998). MISR prelaunch instrument calibration and characterization results. *IEEE Trans. Geosci. Rem. Sens.*, Vol. 36, pp. 1186-1198.
- Bruegge, C.J., D.J. Diner, and V.G. Duval (1996). The MISR calibration program. *J. of Atmos. and Oceanic Tech.*, Vol. 13 (2), 286-299.
- Bruegge, C.J., V.G. Duval, N.L. Chrien, and D.J. Diner (1993). Calibration Plans for the Multi-angle Imaging SpectroRadiometer (MISR). *Metrologia*, 30 (4), 213-221.

Conference papers/ Workshop proceedings

- Chrien, N.C.L., C.J. Bruegge, and B.R. Barkstrom (1993). Estimation of calibration uncertainties for the Multi-angle Imaging SpectroRadiometer (MISR) via fidelity intervals. In *Sensor Systems for the Early Earth Observing System Platforms*, Proc. SPIE 1939, April, 114-125.

Ph.D. Thesis/ Technical Reports

- Bruegge, C.J. (1991). Definitions in use by the Visible and Near-Infrared and Thermal Working Groups, Earth Observing System Calibration Advisory Panel. Memo, October 8.
- Bruegge, C.J. (1991). Cross-calibration survey, Earth Observing System Calibration Advisory Panel VISNIR working group. Memo, October 11.

Georectification and photogrammetry

Refereed Journals

- Jovanovic, V.M., M. M. Smyth, J. Zong, R. Ando, and G. W. Bothwell (1998). MISR Photogrammetric Data Reduction for Geophysical Retrievals. *IEEE Transaction on Geoscience and Remote Sensing*, Vol. 36, No. 4, July.

Conference papers/ Workshop proceedings

- Jovanovic, Veljko M. and Michael M. Smyth (1999). MISR global inflight geometric calibration concept. Conference: In-orbit Geometric Characterization of Optical Imaging Systems. Conference sponsored by IGN, ISPRS, SfPt, and CNES, Bordeaux, France, 2-5 November.
- Jovanovic, V.M., M. M. Smyth, and J. Zong (1996). Autonomous and Continuous Georectification of Multi-Angle Imaging Spectro-Radiometer (MISR) Imagery. International Archives of Photogrammetry and Remote Sensing, Volume 31-B2, Vienna, Austria.
- Zong, J., M.M. Smyth, and Veljko M. Jovanovic (1996). MISR band-to-band registration. In *Multispectral Imaging for Terrestrial Applications*. Proc. SPIE **2818**, Denver, Co, 5-9 August.

In-flight radiometric calibration

Refereed Journals

- Bruegge, Carol, Nadine Chrien, and David Haner (1999). A Spectralon BRF data base for MISR calibration applications. Submitted to *Remote Sens. Environment*.
- Bruegge, C.J., N. L. Chrien, R. A. Kahn, J. V. Martonchik, David Diner (1998). MISR radiometric uncertainty analyses and their utilization within geophysical retrievals. Conference issue: New Developments and Applications in Optical Radiometry (NEWRAD '97), *Metrologia*, **35**, 571-579.

Conference papers/ Workshop proceedings

- Chrien, N.L. and C.J. Bruegge (1996). Out-of-band spectral correction algorithm for the Multi-angle Imaging SpectroRadiometer. In *Earth Observing System*. Proc. SPIE **2820**, Denver, Co, 5-9 August.

Performance verification

Conference papers/ Workshop proceedings

- Bruegge, C.J., and D.J. Diner (1997). Instrument verification tests on the Multi-angle Imaging SpectroRadiometer (MISR). In *Earth Observing Systems II*, SPIE **3117**, San Diego, CA, 28-29 July.
- Bruegge, C.J., N.L. Chrien, B.J. Gaitley, and R.P. Korechoff (1996). Preflight performance testing of the Multi-angle Imaging SpectroRadiometer cameras. In *Satellite Remote Sensing III*, Proc. SPIE **2957**, Taormina, Italy, 23-26 September 1996.
- Bruegge, C.J., V.G. Duval, N.L. Chrien, and R. P. Korechoff (1995). MISR instrument development and test status. In *Advanced and Next-Generation Satellites*. Proc. EUROPTO/ SPIE **2538**, 92-103, Paris, France, 25-28 September.
- Hochberg, E.B., and N.C. L. Chrien (1996). Lloyds mirror for MTF testing of MISR CCD. In *Optical Spectroscopic Techniques and Instrumentation for Atmospheric Space Research II*. Proc. SPIE **2830**, Denver, CO, 5-9 August.
- Hochberg, E.B., M.L. White, R.P. Korechoff, C.A. Sepulveda (1996). Optical testing of MISR lenses and cameras. In *Optical Spectroscopic Techniques and Instrumentation for Atmospheric Space Research II*. Proc. SPIE, VOL. 2830 Denver, CO, 5-9 August.
- Korechoff, R.P, D.J. Diner, D.J. Preston, C.J. Bruegge (1995). In Advanced and Next-Generation Satellites. Spectroradiometer focal-plane design considerations: lessons learned from MISR camera testing. EUROPTO/ SPIE Vol. 2538, pp. 104-116, 25-28 September.
- Korechoff, R., D. Kirby, E. Hochberg, C. Sepulveda, and V. Jovanovic (1996). Distortion calibration of the MISR linear detectors. In *Earth Observing System*. Proc. SPIE **2820**, Denver, Co, 5-9 August.

Vicarious calibration

Refereed Journals

Abdou, W.A., C.J. Bruegge, M.C. Helmlinger, B.J. Gaitley, W.C. Ledebot, S.H. Pilorz, J.E. Conel, and J.V. Martonchik (1999). Vicarious reflectance-based absolute radiometric calibration of AirMISR, Submitted, *Remote Sens. of Environment*.

Thome, K., S. Schiller, J. Conel, K. Arai, S. Tsuchida (1998). Results of the 1996 Earth Observing System vicarious calibration joint campaign at Lunar Lake Playa, Nevada (USA). Conference issue: New Developments and Applications in Optical Radiometry (NEWRAD '97). *Metrologia*, **35**, 631-638.

Ph.D. Thesis/ Technical Reports

Bruegge (Kastner), C.J., In-flight absolute radiometric calibration of the Landsat Thematic Mapper, Ph.D. dissertation, Univ. of Arizona, 1985.

5

Data products/ processing

Data product overview

Conference papers/ Workshop proceedings

Banerjee, Pranab, Kathleen Crean, and Ralph Kahn (1998). An Approach to Assessing the Quality of Large Scientific Datasets from Satellites, Using EOS-AM1 MISR as an Example. American Geophysical Union, U11A-18, San Francisco, CA, December 6-10.

Kahn, R.A. (1995). What shall we do with the data we are expecting in 1998? In proc. *Massive Data Sets Workshop*, National Academy of Sciences, Washington, D.C., 7-8Jul.

Kahn, Ralph (1998). Why do we Need Discrete Global Grids for Satellite Remote Sensing?" Computing Science and Statistics, Proceedings of the 30th Symposium on the Interface, Minneapolis, MN, May 13-16, p.285.

Lewicki, S.A., Smyth, M.M., Jovanovic, V.M., Hansen, E.G. (1994). A Simulation of MISR Imagery for Prototyping of the MISR Ground Data System. IGARSS'94, 8-12 Aug, Pasadena, CA.

Level 1B1 radiometric product

Conference papers/ Workshop proceedings

Bruegge, C.J., R.M. Woodhouse, D.J. Diner (1996). In-flight radiometric calibration plans for the Earth Observing System Multi-angle Imaging SpectroRadiometer. IEEE/IGARSS, Paper No. 96.1028, Lincoln, Nebraska, 27-31 May.

Quality assessment

Ph.D. Thesis/ Technical Reports

- Kahn, R.A., K. Crean, D. Diner, E. Hansen, J. Martonchik, S. McMuldroch, S. Paradise, R. Vargo, R. West (1996). Quality Assessment for MISR Level 2 Data. *The Earth Observer*, Vol. 8(1), Jan/ Feb., pp. 19-21.
 - Kahn, R., D. Diner, J. Martonchik, J. Conel, R. Vargo, D. Wenkert, R. West, C. Bruegge, W. Abdou, E. Hansen, S. Paradise, K. Crean, B. Rheingans, and D. McDonald (1995). How will we choose which quality flags and constraints to report for MISR Level 2 data? *The Earth Observer* 7, May/June, 32-33.
-

6

General interest

News media

- Kahn, Ralph (1998). Painting a New, Far More Detailed Portrait of Earth. *Los Angeles Times*, February 26.
- Kahn, Ralph (1998). New eye in the sky charts Earth's green breathing. *Los Angeles Times*, June 4.

Related publications

- Hileman, Bette (1999). Case grows for climate change. *Chemical and engineering news*, 9Aug, cover story pp. 16-23.
- Kahn, Ralph (1998). The Box. *Smithsonian Air and Space*, 24-25 Aug/ Sept.
- Kahn, R., and D. Wenkert (1997). The Earth Observing System, *Encyclopedia of Planetary Sciences*. Ed. J. H. Shirley and R. W. Fairbridge, Chapman and Hall, pp. 211-215.
- NASA Facts (1999). Goddard Space Flight Center. FS-1999-08-028-GSFC.
- Mecham, Michael(1999). Building on past missions, Terra sets stage for more. *Aviation Week*. October 6.
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Updates

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